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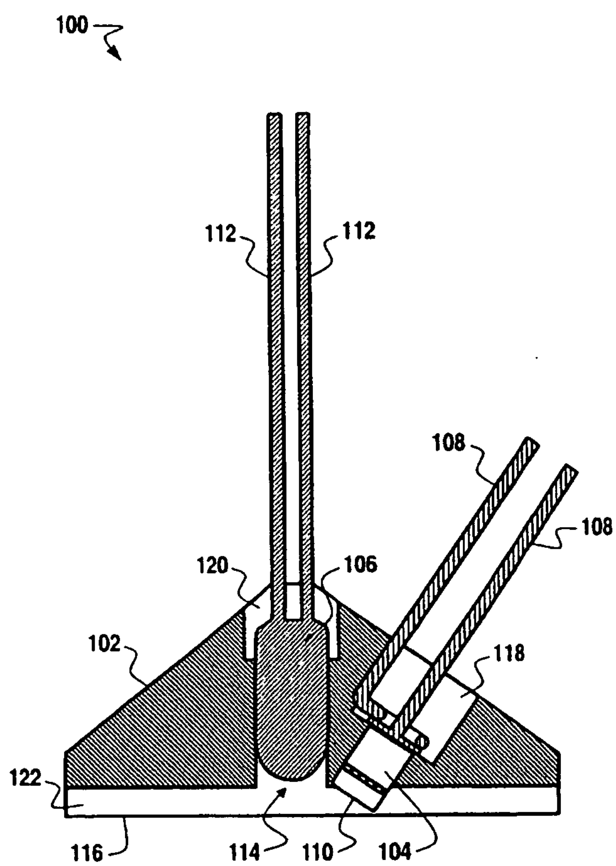
(54) Title: VERSATILE METHOD AND SYSTEM FOR VCSEL-BASED BAR CODE SCANNER

(57) Abstract: A versatile system and method for VCSEL (vertical cavity surface emitting laser) bar code and data scanning is disclosed, including a housing (102) having a scanning surface (116), a detector element (106) disposed within the housing in close proximity and normal to the scanning surface, VCSEL component (104) disposed within the housing in close proximity to the detector element and scanning surface, and an aperture (122) formed within the housing between the scanning surface and the detector element.



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VERSATILE METHOD AND SYSTEM FOR VCSEL-BASED BAR CODE SCANNER

BACKGROUND OF THE INVENTION

The present invention relates, in general, to data coding and, in particular, to a versatile system for Vertical Cavity Surface-Emitting Laser (VCSEL)-based bar code reading and scanning.

Bar code scanning is used in a vast array of commercial and industrial applications for convenient and efficient transfer of data and information. As requirements for faster processing of greater amounts of information have increased, efforts have been made to increase the efficiency and effectiveness of bar code scanning. In general, the amount and efficiency of information that a particular bar code can transfer is limited by the minimum required width of any individual bar (i.e. the pitch) in that code. As the minimum required bar width decreases (i.e. a smaller pitch is achieved), a greater number of bars can be coded in a given space. Thus, the amount of data coded in that given space, using small pitch bar coding, is increased, resulting in a more efficient system.

One major limitation on small pitch bar coding is the resolution of bar code reading systems. Where a bar code reading system lacks sufficient resolution to accurately distinguish small pitch bar codes, data transfer becomes unreliable and error prone. It is, thus, desirable to provide accurate and reliable small pitch bar code reading.

Conventional small pitch bar code reading and scanning systems generally use lasers in conjunction with optical lensing to generate and concentrate sufficient illumination on the media to be scanned and enable scanning of small pitch lines. Such systems usually suffer from optical inefficiency (due to the lensing), consume a relatively large amount of power (to compensate for the inefficiency), and are costly as a result of the extra componentry. Most conventional laser scanning systems also have a scan pattern that limits the total bar code width. One well-known variety of laser bar code scanner, sometimes referred to as free-space scanners (e.g., a retail cash register scanner), usually comprises a relatively large amount of componentry used to manipulate the laser beam back and forth across the bar code for proper reading. Some such systems employ lasers and multiple rotating mirrors to accomplish reading. These systems, while capable of reading small pitch bar codes, are very expensive and highly impractical for anything but retail applications. For most non-retail applications, a close-proximity bar code scanning system will suffice, rendering most conventional laser scanning systems highly inefficient.

Other conventional scanning and reading systems have utilized standard infrared and visible LEDs (light emitting diodes) as light sources for bar code scanning and reading. Again, such systems are limited as they require significantly more power (i.e. LED current) and optical lensing to provide sufficient illumination to produce a usable read signal. This results in increased space requirements and system costs. Also, such scanning systems are typically less accurate on small pitch bar codes, as they are generally limited by the size

of the LED source, which is relatively large in comparison to the pitch of the bar code. Thus, LED-based scanning systems can also suffer from accuracy and reliability problems.

Further complicating the efficiency and performance of conventional bar code scanning, clocking systems have generally added to the complexity and cost of conventional systems while providing very restrictive clocking schemes and scenarios. Clocking is important, especially in bar code scanning, for accurate data transfer. Most bar code systems rely on manual movement of the bar code in relation to the scanner: either the bar code is passed over the stationary scanner, or the scanner is passed over the stationary bar code. Accurate interpretation of the bar code depends on the ability to differentiate individual bar widths. Unless a fixed, constant-rate scanning speed is guaranteed, some sort of reference signal (i.e. a clocking signal) must be utilized to time the scanning. Some conventional systems have relied on pre-set fixed-rate scanning, usually employing some sort of internal clocking system independent of the bar coding. This approach adds to system cost and complexity. Other conventional systems have relied on clocking signals read as part, or in conjunction with, a particular bar code. Typically, though, the relatively poor resolution of such systems either required a slow scan rate or tolerance for greater system unreliability.

BRIEF SUMMARY OF THE INVENTION

The following summary of the invention is provided to facilitate an understanding of some of the innovative features unique to the present invention and is not intended to be a full description. A full appreciation of the various aspects of the invention can be gained by taking the entire specification, claims, drawings, and abstract as a whole.

A versatile system for scanning or reading small pitch bar code and other similarly formatted data in a cost-effective, highly accurate and reliable manner while minimizing power consumption is now needed; providing readily adaptable close-proximity scanners and readers while overcoming the aforementioned limitations of conventional methods.

In the present invention, a VCSEL component and a detector are provided in close or predefined proximity to a media-reading area such that the detector receives diffuse angle reflections from the VCSEL component off a media being scanned; providing highly accurate small pitch scanning and reading in a highly cost-effective and readily adaptable manner.

The present invention provides a data scanning device comprising a housing having a scanning surface, a detector element disposed within the housing normal to the scanning surface, an aperture formed within the housing between the scanning surface and the detector element, and a laser source disposed within the housing adjoining the aperture.

The present invention also provides a diffuse reflective bar code reading system comprising a housing having a scanning surface, a detector element disposed within the housing in close proximity and normal to the scanning surface, a VCSEL component disposed within the housing in close proximity to the detector element and scanning surface, and an aperture formed within the housing between the scanning surface and the detector element.

The present invention further provides a method of optoelectronic data scanning, comprising the steps of providing a scanning surface having a target area, providing an optoelectronic detector disposed in close proximity and normal to the target area, providing a VCSEL component disposed in close proximity to the detector element and target area, adapted to source light to the target area from a diffuse angle, and receiving VCSEL-sourced light reflected from the target with the detector.

The novel features of the present invention will become apparent to those of skill in the art upon examination of the following detailed description of the invention or can be learned by practice of the present invention. It should be understood, however, that the detailed description of the invention and the specific examples presented, while indicating certain embodiments of the present invention, are provided for illustration purposes only because various changes and modifications within the scope of the invention will become apparent to those of skill in the art from the detailed description of the invention and claims that follow.

BRIEF DESCRIPTION OF THE DRAWINGS

The accompanying figures, in which like reference numerals refer to identical or functionally-similar elements throughout the separate views and which are incorporated in and form part of the specification, further illustrate the present invention and, together with the detailed description of the invention, serve to explain the principles of the present invention.

FIG. 1 is an illustrative diagram of a data scanning device according to the present invention;

FIG. 2 is a side-view schematic of the device from FIG. 1;

FIG. 3 is an illustrative diagram of another data scanning device according to the present invention; and

FIG. 4 is a plan-view schematic of the device from FIG. 3.

DETAILED DESCRIPTION OF THE INVENTION

While the making and using of various embodiments of the present invention are discussed in detail below, it should be appreciated that the present invention provides many applicable inventive concepts which can be embodied in a wide variety of specific contexts. The specific embodiments discussed herein are merely illustrative of specific ways to make and use the invention and do not delimit the scope of the invention.

It should be understood that the principles and applications disclosed herein can be applied in a wide range of optoelectronic applications. The present invention solves problems associated with reading bar code type information of varying media types, inks, and surfaces, while minimizing power consumption and system costs. The present invention provides for greater bar code printing density. The present invention can incorporate a clocking channel, providing accurate reading independent of scan speed or bar code spacing tolerances. The present invention can be applied in a number of surface scanning applications, as well as applications requiring the accuracy of a clocking channel or low-power consumption. For example, the present invention could be applied in a variety of high-accuracy edge detection applications (e.g., printers, copiers), directional analysis applications, and rotary or linear encoder/decoders. For purposes of explanation and illustration, the present invention is hereafter described in reference to close proximity bar code scanning or reading system. The system of the present invention can be deployed in a fixed position scanning assembly, or in a movable reading assembly (e.g. a pen-type wand).

The present invention utilizes a Vertical Cavity Surface Emitting Laser (VCSEL) as a light source. The VCSEL is rapidly becoming a workhorse technology for semiconductor optoelectronics. VCSELs can typically be used as light emission sources anywhere other laser sources are used and provide a number of advantages to system designers. Hence, VCSELs are emerging as the light source of choice for modern high speed, short-wavelength communication systems and other high-volume applications, such as optical encoders, reflective/transmissive sensors and optical read/write applications. Inherently low cost of manufacture, enhanced reliability, non-astigmatic and circularly symmetric optical output are just some of the advantages of VCSELs over traditional laser sources.

Within the context of the present invention, a number of VCSEL characteristics are particularly desirable and advantageous. VCSELs can provide a source beam having substantial light intensity, without requiring additional lensing or amplification, in a focused area with low-beam divergence. Additionally, VCSEL sources are well suited for low-beam angle applications. The benefits of these characteristics are more fully appreciated in reference to FIGs. 1-4.

Referring now to FIG. 1, aspects of the present invention are illustrated in one embodiment of a reading assembly 100 according to the present invention. Assembly 100 comprises a housing 102, a VCSEL component 104, and a detector component 106. As depicted, VCSEL component 104 can comprise a hermetic VCSEL in a flat window

package having control leads 108 and sourcing light from surface 110. As depicted, detector element 106 can comprise a silicon photodetector in a T-1 package having control leads 112 and receiving light within acceptance area 114. Housing 102 can be formed with a scanning surface 116 and chambers 118 and 120, into which components 104 and 106 are disposed, respectively. Housing 102 also has formed therein a light restricting aperture 122. As illustrated in FIG. 2, which depicts a side view 200 of assembly 100, aperture 122 can comprise a narrow slot or slit traversing the scanning surface 116.

Operationally, a particular bar code or other similar media to be read is passed along surface 116, in direct contact or very close proximity thereto. A desired media can be passed along a fixed-position assembly 100, or alternatively, a movable assembly 100 can be passed along a desired media. When a printed pattern is passed along surface 116, assembly 100 can distinguish not only high-uality printed bars (e.g., those produced by laser printers), but can also discriminate other print and media surface features (e.g., offset printing on newsprint). Elements 104 and 106 are disposed within housing 102, and aperture 122 is formed such that acceptance area 114 of detector 106 receives only light diffused from a target area on the desired media (not shown), and all specular and stray light is blocked or ignored. This target area is generally a very small space just below surface 116, centered directly under acceptance area 114. Elements 104 and 106 are disposed within housing 102 in very close proximity to scanning surface 116 (e.g., 0.02"-0.05"). VCSEL 104 is disposed within housing 102 at an angle sufficient to maximize the diffuse light reflected from the target area. Because the maximum intensity reflection is

desired normal to the target area (at acceptance area 114), and because the intensity of reflection is a function of the cosine of the angle at which the light is reflected from the desired media, VCSEL 104 is disposed at an angle to and a distance from surface 116 sufficient to maximize diffuse reflection from the media normal to the target area. Other factors can be varied to provide desired reflective properties and behavior. The dimensioning of aperture 122 can be altered to restrict the intensity and field of light reaching detector 106, providing user-definable resolution. For example, in a system similar to assembly 100, providing aperture 122 widths between 0.01" and 0.005" could provide for line and spacing resolutions of between approximately 0.008" and 0.004", respectively. In general, the smaller aperture 122 is formed to be, the finer (and better) the system resolution will be. Alternatively, VCSEL 104 can be selected or designed to provide a particular wavelength of light, providing for optimal dimensioning and forming of assembly 100.

As depicted, components 104 and 106 can be directly coupled to host control or analytical equipment (e.g., a microprocessor or digital signal processor) via leads 108 and 110, respectively. In most applications, no signal amplification will be required, reducing power consumption requirements of a system. Furthermore, no A/D conversion will be required since the present invention can provide direct digital input into host control or analytical equipment. Additionally, the present invention thus provides the ability to design using low voltage devices, further reducing system power requirements and costs while improving system reliability.

Housing 102 can be formed by any suitable method or process (e.g., injection molding), and can be pre-formed for later insertion of components 104 and 106, or formed around or concurrently with those components. Housing 102 can itself constitute a stand-alone reader/scanner structure, or it can be one element of some other reader/scanner structure (e.g., a pen-type wand assembly). Detector 106 can comprise any suitable contrivance for receiving reflected light and transmitting corresponding signals. For example, detector 106 can comprise a silicon photodetector in a different package (e.g., can-type package) or a flat-panel window-type detector. Similarly, VCSEL component 104 can be packaged or arranged in any suitable manner (e.g., a single VCSEL surface mounted on a substrate). Thus assembly 100 can be adapted, modified, and formed in a number of ways comprehended by the present invention. For example, housing 102, detector 106 and VCSEL104 can be formed or disposed on a single substrate using suitable semiconductor processing technologies.

Referring now to FIG. 3, another embodiment of a scanner/reader system 300 in accordance with the present invention is illustrated. Assembly 300 can be considered to comprise dual assemblies 100. The present invention thus provides two channels; one of which can be used for clocking purposes and other can be used for data retrieval. More specifically, assembly 300 comprises a housing 302, a first VCSEL component 304, a second VCSEL component 306, a first detector component 308 and a second detector component 310. As depicted, VCSEL components 304 and 306 can comprise hermetic

VCSELs in flat-window packages having control leads 312 and 314, respectively. As depicted, detector components 308 and 310 can comprise silicon photodetectors in T-1 packages having control leads 316 and 318, respectively. Housing 302 is formed with scanning surface 320 and light restricting aperture 322. The detectors, VCSELs, and aperture are formed or disposed such that detector 308 receives only reflected light generated by VCSEL 304, and detector 310 receives only reflected light generated by VCSEL 306. As depicted in FIG. 3, there is no barrier within aperture 322 between the two channels. Assembly 300 is configured such that any stray light from VCSEL 304 reflected off a desired media would be outside the acceptance angle of detector 310, and likewise, stray light from VCSEL 306 reflected off a desired media would be outside the acceptance angle of detector 308. In some embodiments, however, it may be desirable to design the application such that light generated by VCSEL 304 is received by detector 310 and light generated by VCSEL 306 is received by detector 308.

Alternatively, some suitable barrier could be formed or disposed between the two channels if desired. Optionally, assembly 300 further comprises a barrier 324 formed or disposed within housing 302 and spanning aperture 322. Barrier 324 can be provided to protect the detectors and VCSELs from hazards associated with continual operation (e.g., collection of paper dust) that may impair the performance of assembly 300. Barrier 324 can be formed of a suitable material (e.g., plastic or glass), selected such that its physical properties will not interfere with the diffuse reflection operation of the VCSELs and

detectors. Generally, specular reflections from a plastic or glass material will not impact the diffuse reflection operation of the present invention.

FIG. 4 provides an illustration of the operation of assembly 300. A center line between the two channels is denoted by indicators 400. Indicators 400 are shown for illustrative purposes and do not have to be incorporated in assembly 300. Alternatively, indicators 400 can comprise some visible marking (e.g., ink dot) or can comprise an additional aperture formed normal to aperture 322. Data to be read by the first channel, VCSEL 304 and detector 308, is generally passed along the path indicated by indicator 402. Data to be read by the second channel, VCSEL 306 and detector 310, is generally passed along the path indicated by indicator 404. Media can be passed continuously across surface 320, as the present invention imposes no maximum length restriction on the bar code or surface analyzed.

The present invention thus provides capacity for multiple scanning/reading channels in a single assembly and so provides in a simple and cost-effective manner. Utilizing the teaching of the present invention, any desired number of channels can be incorporated into a scanning assembly based on particular design requirements (e.g., multi-channel linear or rotary encoding).

The embodiments and examples set forth herein are presented to best explain the present invention and its practical application and to thereby enable those skilled in the art

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to make and utilize the invention. Those skilled in the art, however, will recognize that the foregoing description and examples have been presented for the purpose of illustration and example only. Other variations and modifications of the present invention will be apparent to those of skill in the art, and it is the intent of the appended claims that such variations and modifications be covered. For example, laser sources other than VCSEL components can be utilized based on particular design requirements, provided that they source light in a manner consistent with the teaching of the present invention. The description as set forth is not intended to be exhaustive nor to limit the scope of the invention. Many modifications and variations are possible in light of the above teaching without departing from the spirit and scope of the following claims. It is contemplated that the use of the present invention can involve components having different characteristics. It is intended that the scope of the present invention be defined by the claims appended hereto, giving full cognizance to equivalents in all respects.

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CLAIMS

The embodiments of an invention in which an exclusive property or right is claimed are defined as follows:

1. A data scanning device comprising:

a housing having a scanning surface;

a detector element disposed within the housing normal to the scanning surface;

an aperture formed within the housing between the scanning surface and the detector element; and

a laser source disposed within the housing adjoining the aperture.

2. The device of claim 1 wherein the housing is disposed within a fixed data scanning assembly.

3. The device of claim 1 wherein the housing is disposed within a movable data reading assembly.

4. The device of claim 1 wherein the housing, detector element, laser source, and aperture are formed on a substrate.

5. The device of claim 1 wherein the detector element is a silicon photo detector.

6. The device of claim 1 wherein said laser source is a vertical cavity surface emitting laser.

7. The device of claim 1 wherein said aperture comprises a slit spanning the scanning surface.

8. The device of claim 1 further comprising a barrier disposed along the scanning surface and covering the aperture.

9. The device of claim 8 wherein the barrier comprises a plastic material.

10. The device of claim 8 wherein the barrier comprises a glass material.

11. The device of claim 1 further comprising:

a second detector element disposed within the housing normal to the scanning surface, adjoining the aperture and distally separate from the first detector element; and

a second laser source disposed within the housing adjoining the aperture and distally separate from the first detector element and first laser source.

12. A diffuse reflective bar code reading system comprising:

a housing having a scanning surface;

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a detector element disposed within the housing in close proximity and normal to the scanning surface;

a VCSEL component disposed within the housing in close proximity to the detector element and scanning surface; and

an aperture formed within the housing between the scanning surface and the detector element.

13. The system of claim 12 wherein the housing is disposed within a fixed data scanning assembly.

14. The system of claim 12 wherein the housing is disposed within a movable data reading assembly.

15. The system of claim 12 wherein the housing, detector element, laser source, and aperture are formed on a substrate.

16. The system of claim 12 wherein said aperture comprises a slit spanning the scanning surface.

17. The system of claim 12 further comprising a barrier disposed along the scanning surface and covering the aperture.

18. The system of claim 17 wherein the barrier comprises a plastic material.

19. The system of claim 17 wherein the barrier comprises a glass material.

20. A method of optoelectronic data scanning, comprising the steps of:

providing a scanning surface having a target area;

providing an optoelectronic detector disposed in close proximity and normal to the target area;

providing a VCSEL component disposed in close proximity to the detector element and target area, adapted to source light to the target area from a diffuse angle; and

receiving VCSEL-sourced light reflected from the target with the detector.

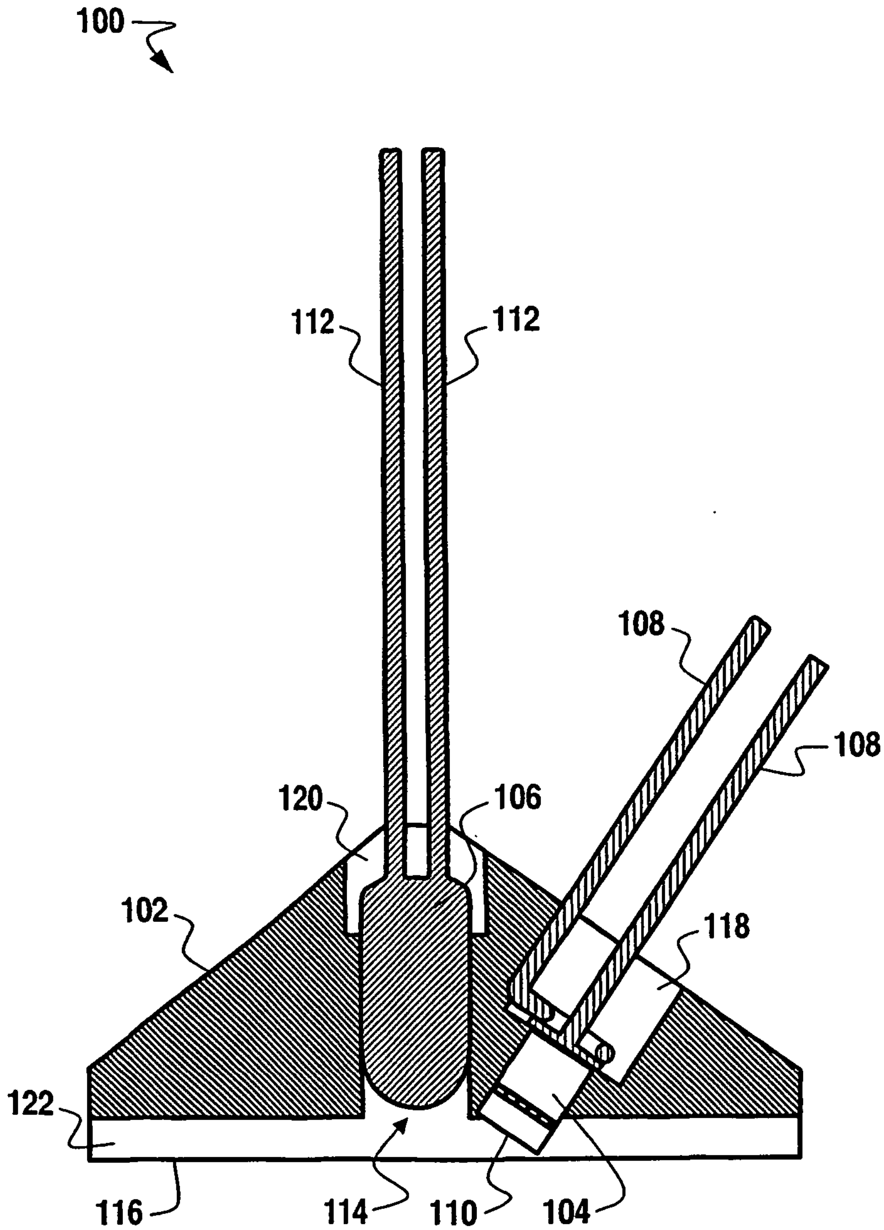

Fig. 1

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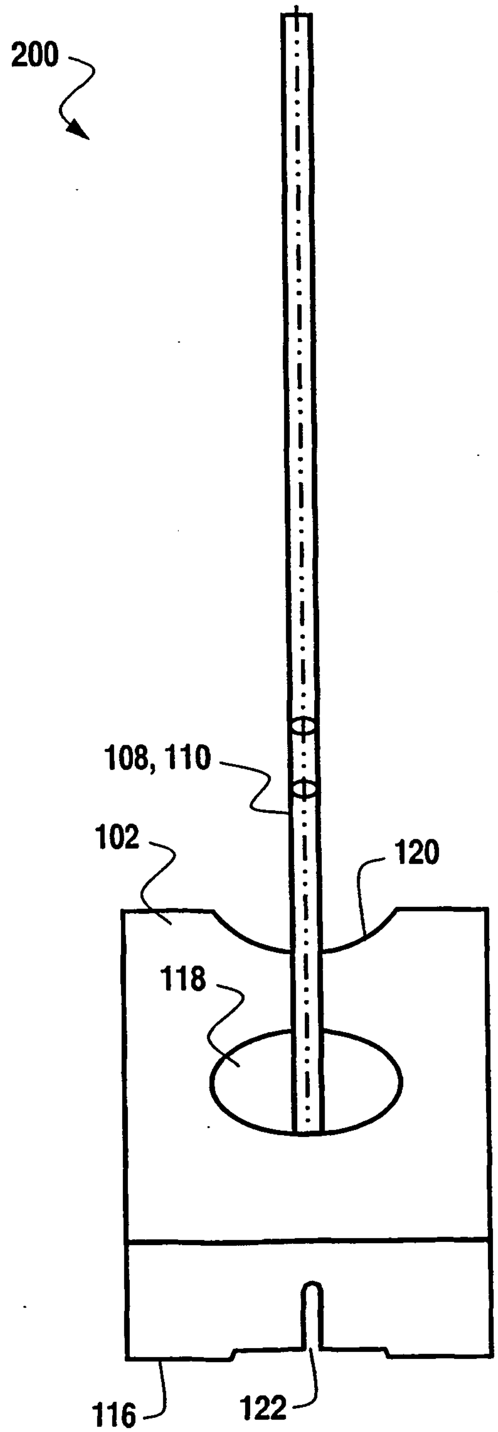

Fig. 2

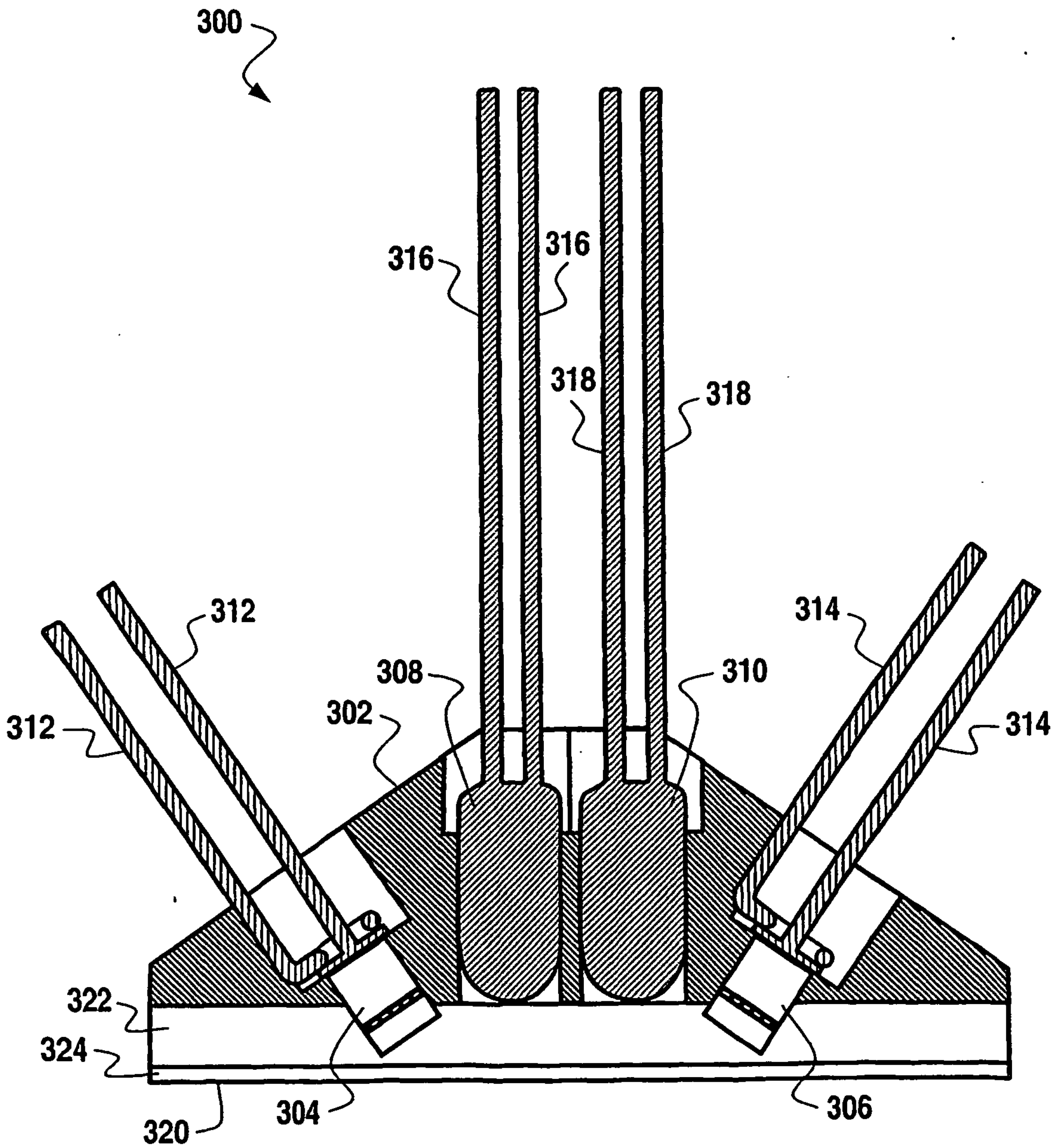

Fig. 3

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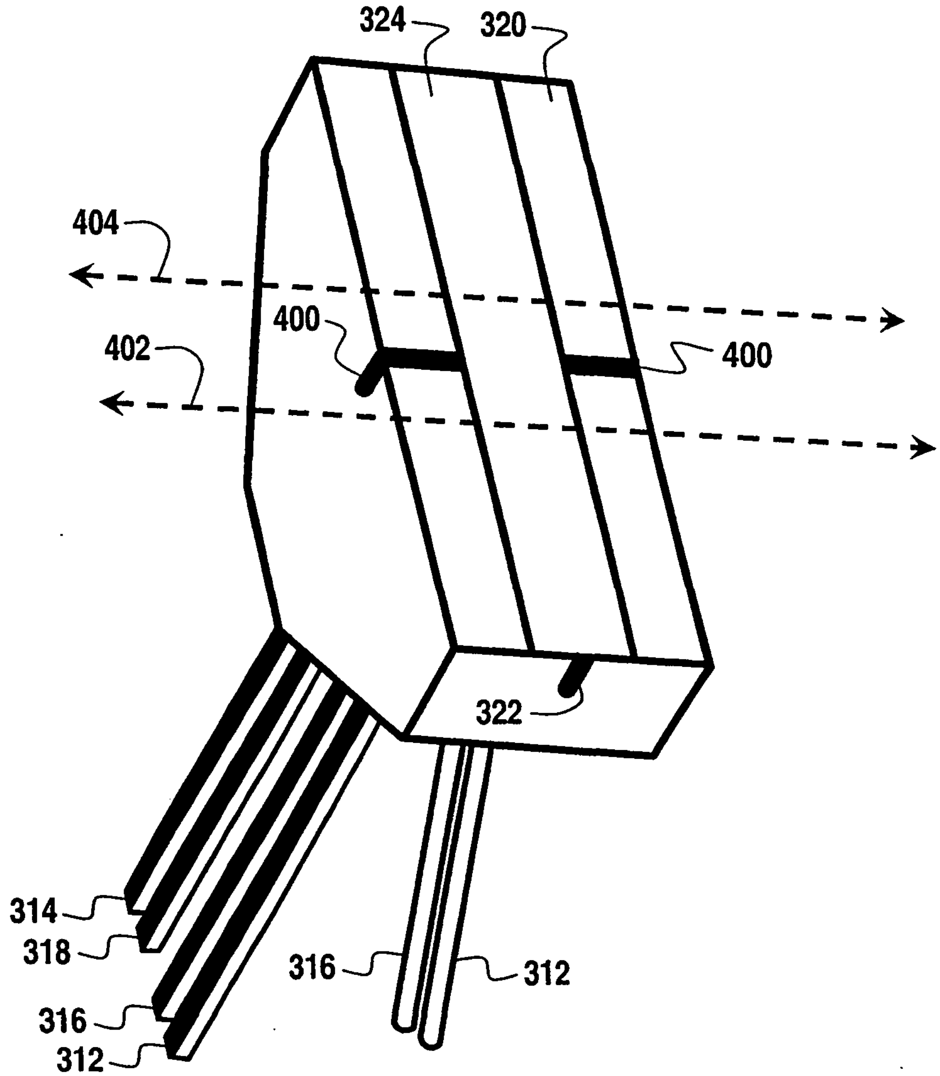

Fig. 4

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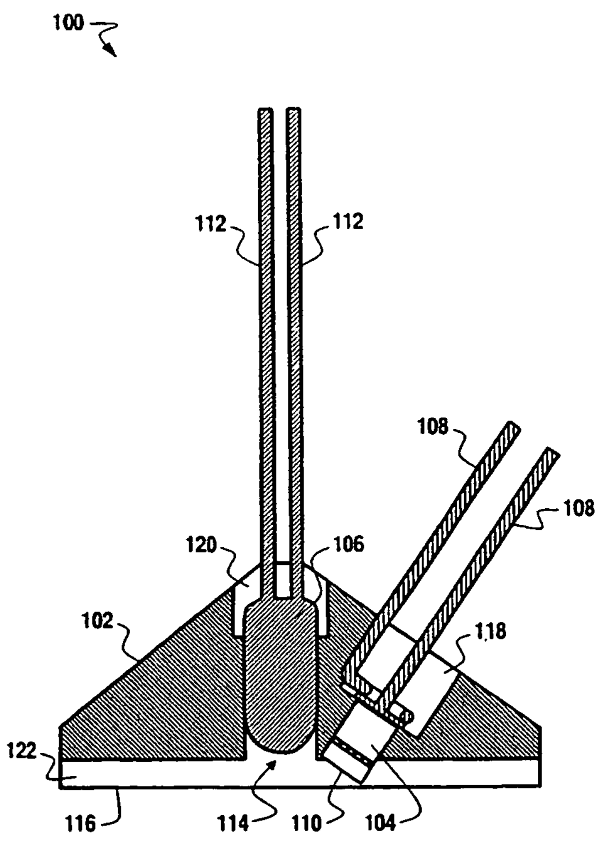

(57) Abstract: A versatile system and method for VCSEL (vertical cavity surface emitting laser) bar code and data scanning is disclosed, including a housing (102) having a scanning surface (116), a detector element (106) disposed within the housing in close proximity and normal to the scanning surface, VCSEL component (104) disposed within the housing in close proximity to the detector element and scanning surface, and an aperture (122) formed within the housing between the scanning surface and the detector element.

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INTERNATIONAL SEARCH REPORT

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A. CLASSIFICATION OF SUBJECT MATTER
IPC 7 G06K7/10

According to International Patent Classification (IPC) or to both national classification and IPC

B. FIELDS SEARCHED

Minimum documentation searched (classification system followed by classification symbols)
IPC 7 G06K

Documentation searched other than minimum documentation to the extent that such documents are included in the fields searched

Electronic data base consulted during the international search (name of data base and, where practical, search terms used)

EPO-Internal, WPI Data, PAJ, IBM-TDB

C. DOCUMENTS CONSIDERED TO BE RELEVANT

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X	US 4 833 336 A (KRASKE BERNHARD) 23 May 1989 (1989-05-23) column 2, line 40 -column 3, line 3; figure 1	1,12,20
X	DE 30 27 769 A (VIDEOTON ELEKTRONIKAL VALLALAT) 25 February 1982 (1982-02-25) page 10, paragraph 3 -page 11, paragraph 7; figures 3-7	1,2, 11-13,20
A	US 6 033 090 A (SEO SHUZO) 7 March 2000 (2000-03-07) column 4, line 18-49; figure 1	1,12,20

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[X] Further documents are listed in the continuation of box C.

[X] Patent family members are listed in annex.

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Date of the actual completion of the international search	Date of mailing of the international search report
9 January 2002	13/02/2002

Name and mailing address of the ISA	Authorized officer
European Patent Office, P.B. 5818 Patentlaan 2 NL - 2280 HV Rijswijk Tel. (+31-70) 340-2040, Tx. 31 651 epo nl, Fax: (+31-70) 340-3016	Schauler, M

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INTERNATIONAL SEARCH REPORT

International Application No
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C.(Continuation) DOCUMENTS CONSIDERED TO BE RELEVANT

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Information on patent family members

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